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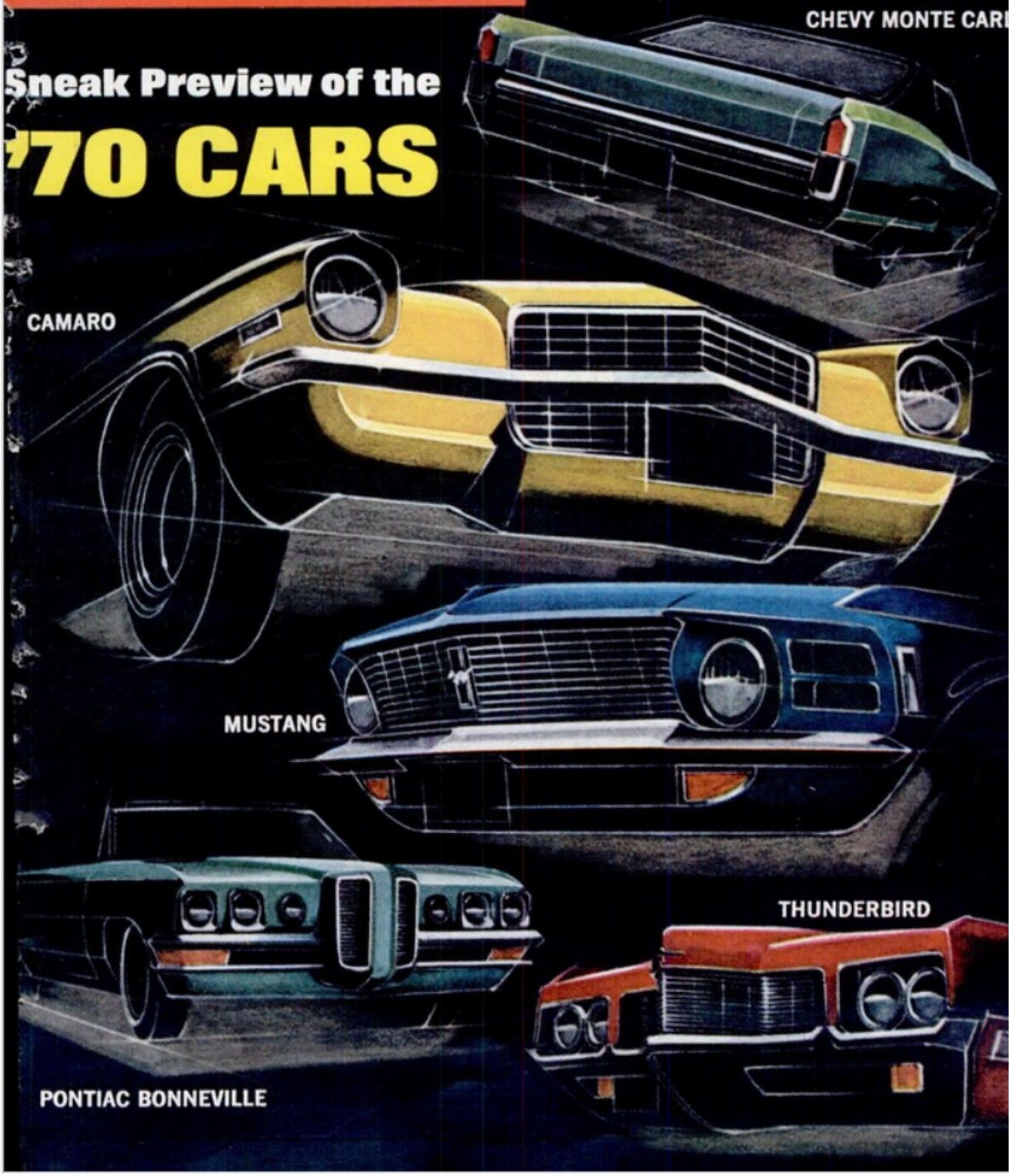

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Modern STEAM CARS Are Really on the Way

By DEVON FRANCIS

Exclusive photos and inside engineering information about the Lear and Minto external-combustion engines

Before the 4th of July, a steam automobile intended for mass production will probably be on test in the U.S.

- Before October, experimental buses will be running in Dallas, Tex., on a vapor that substitutes for steam.
- By spring, 1970, scores of vapor-driven cars will be roaming the highways in evaluation tests.
- By March, 1971, vapor-driven cars

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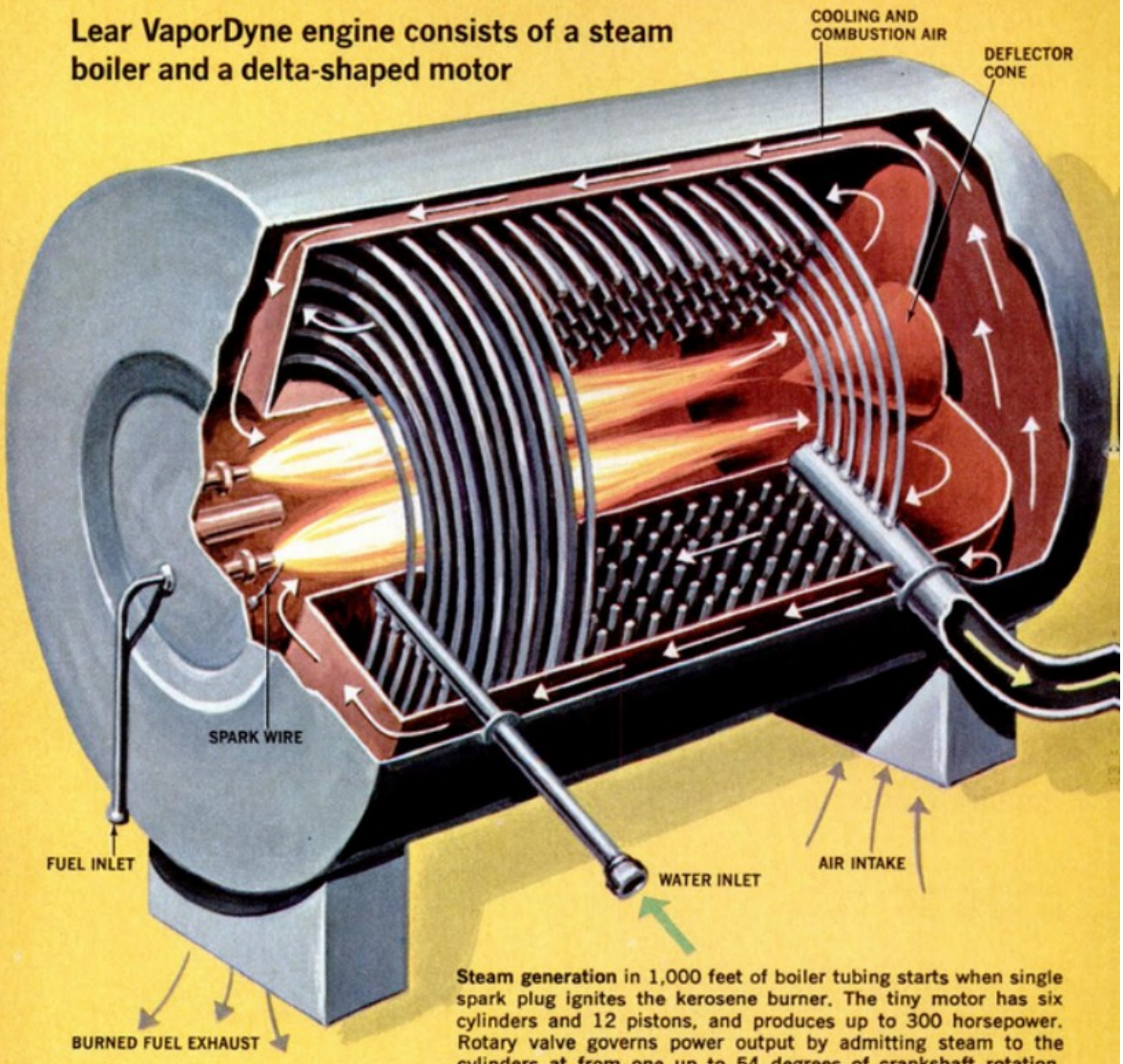
William P. Lear shows how complete steam power plant fits under hood of modern automobile.

Lear VaporDyne engine consists of a steam boiler and a delta-shaped motor



Steam generation in 1,000 feet of boiler tubing starts when single spark plug ignites the kerosene burner. The tiny motor has six cylinders and 12 pistons, and produces up to 300 horsepower. Rotary valve governs power output by admitting steam to the cylinders at from one up to 54 degrees of crankshaft rotation.

may be available in limited quantities in auto showrooms.

After four decades, the steam automobile is coming back.

The car for your garage may not be steam-powered in the conventional sense. The "steam" may be something other than water vapor. But the external-combustion engine as a substitute for the internal-combustion engine is here.

As forecast in POPULAR SCIENCE ["Is There a Steam Car in Your Future?" Sept. '68], crash programs for its improvement suddenly have blossomed. Federal money pouring into the laboratories where these engines are on test is making the difference between back-yard fiddling and production-type hardware.

Why steam cars? The reason for the return of the external-combustion car is the internal-combustion engine's contribution to air pollution (60 percent of all air pollution in the U.S., as much as 90 percent in some urban areas, the Senate Commerce Committee reported in March).

External combustion means simply that fuel is burned outside the engine to produce a vapor to run it. Unlike that in a gasoline engine, combustion is practically complete. Little or no deadly carbon monoxide or unburned hydrocarbons are spewed into the air. The principal gaseous

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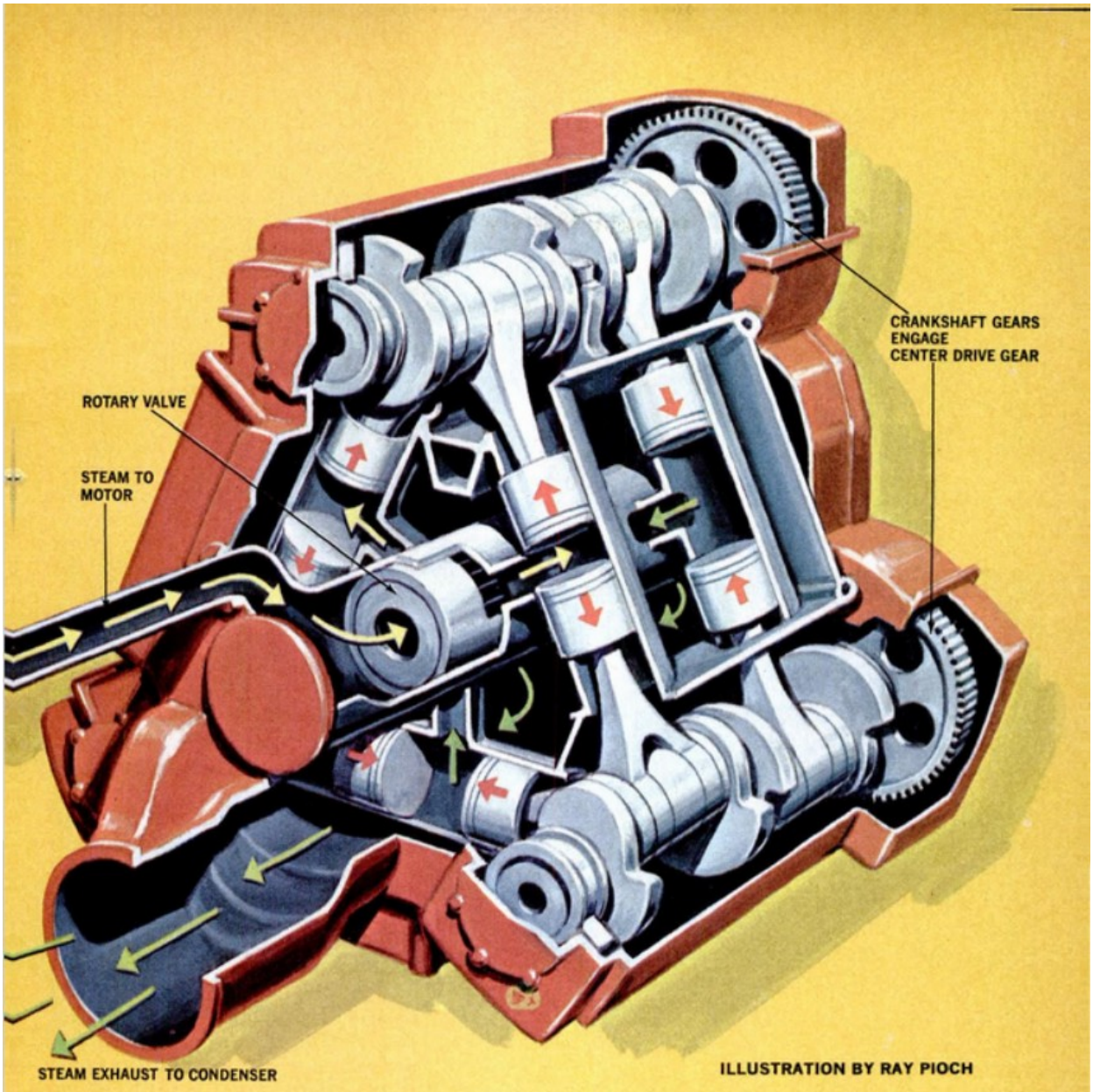

ILLUSTRATION BY RAY PIOCH

product is just harmless carbon dioxide.

The crash programs have produced two vapor systems — vapor generators plus engines. They are meeting head-on in a race for the car market. One is engineered by William Powell Lear, who fathered the Lear jet plane. The other is the product of Wallace Louis Minto, an engineer-scientist who had a role in developing the world's first atomic bomb.

Lear has developed a steam engine; Minto one that substitutes Freon-11 for water. Freon, an innocuous gas, is used in various chemical combinations in air conditioners and refrigerators, and as a pressure agent in aerosol sprays.

I spent some days at the Lear Motors Corp., near Reno, Nev., and at Minto's Kinetics Corp., in Sarasota, Fla., watching the respective systems work.

A lot in common. Both the Lear and Minto designs use a burner much like the one in your furnace — as did yesteryear's Stanley and Doble steam cars — to heat operating fluids in boilers consisting of spiral tubes. Lear burns kerosene. Minto, for the moment uses propane gas, but later will adopt kerosene or diesel fuel. The cycles in both systems are "closed"—vapor exhausted from the motor is condensed to a liquid for re-use. Both dump a lot of heat overboard through condensers or ra-

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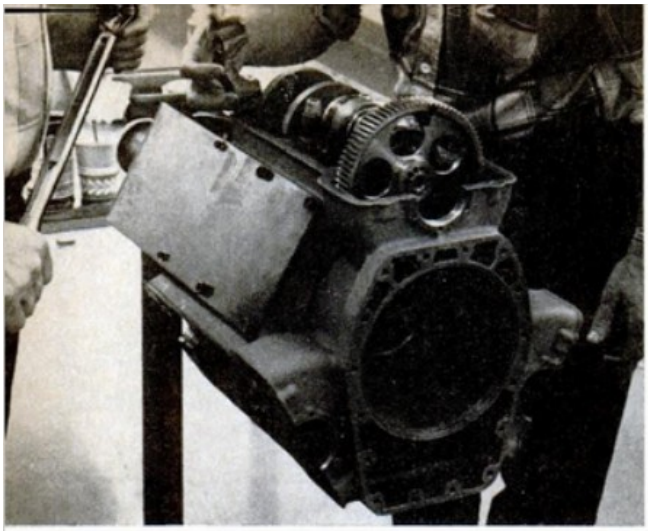
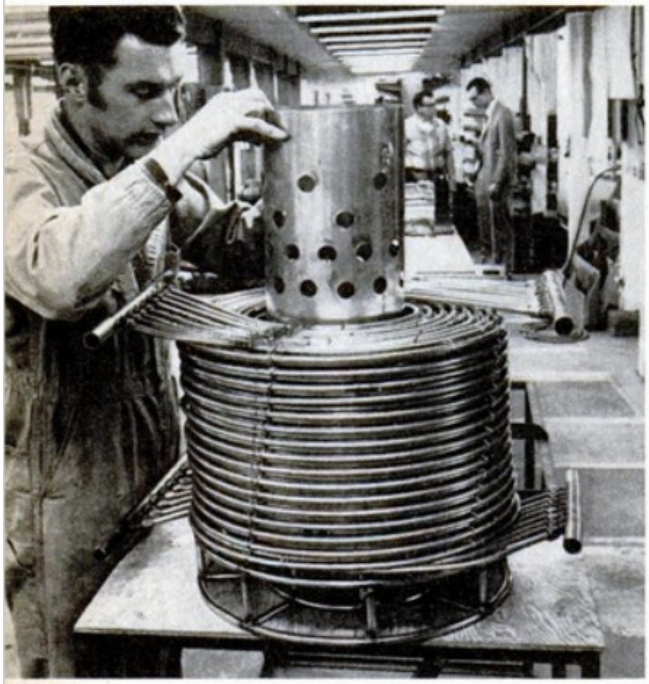
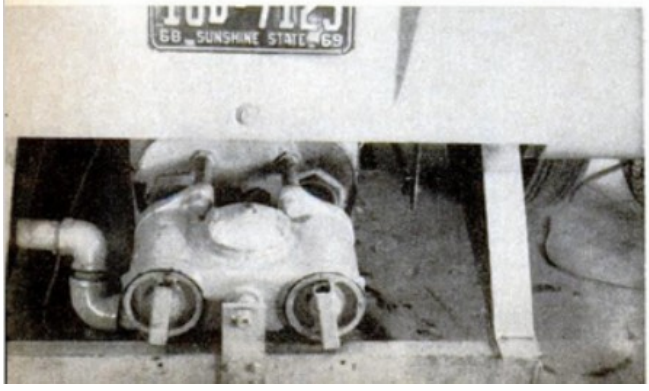


Top crankshaft of Lear VaporDyne engine is installed in the Reno lab. The three crankshafts are placed in A formation, leaving space in middle of block for a rotary valve that admits steam to cylinders.



Prototype boiler with 1,000 feet of stainless-steel tubing has sleeve core with holes for exit of furnace heat. Pump feeds water to coils past check valve under pressure of 2,000 pounds per square inch.



diators. Both motors are reciprocating-piston type. Both systems use a vapor cutoff to the motor to provide an astonishing range of torque and horsepower.

Neither needs a transmission; one of the delights of the external-combustion system is that it develops its greatest torque at stall. Both Lear and Minto tap the vapor generator for power to run auxiliary motors; pumps, alternators, and other accessories must keep going when the main motor is stopped, as at a red light. Both use computers to govern such things as fuel and fluid feeds.

At this point Minto has a leg up on Lear. His design problems are fewer.

Why Freon? Freon has advantages over water. Water freezes at 32 degrees F., Freon-11 at 168 degrees below zero. When water freezes, it expands, causing the plumbing to burst.

To convert one pound of water into steam 570 degrees hot at a pressure of 500 pounds per square inch requires 750 British Thermal Units. To convert one pound of Freon-11 into vapor requires only 32 BTU at the same approximate pressure. In an open container, Freon-11 boils at 74.8 degrees.

That's the principle, but not the whole story by any means. For maximum efficiency, steam motors need vapor superheated to over 1,000 degrees at 2,000 p.s.i. All this heat input causes problems. But Freon motors can use vapor from 385 degrees and at as low as 500 p.s.i. with comparable efficiency.

Steam has a much lower molecular weight than Freon, and provides only one-third the power per unit volume, on a motor's pistons. Therefore, Minto's boiler plumbing is about one-third the weight of Lear's.

Steam's high heat evokes lubrication problems at the pressures employed. Ordinary oils emulsify. By contrast, Freon is a natural lubricant, and at highway speeds does not rise above 360 degrees. With additives, it can be made chemically stable up to 800 degrees. Water, of course, is stable at thousands of degrees.

Minto has a special problem, though. He must avoid copper in his system—at

Tiny 1920 two-cylinder Stanley engine powers Minto test car. Double-acting, it produces four power strokes a revolution. Bore is four inches. stroke five. Vapor cutoff runs full length of cylinder.

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Minto tested Freon engine in converted Volkswagen bus

Wallace Minto wanted space to install his experimental boiler, propane-fuel tank, vapor condenser, and computer—so he used a Volkswagen bus for a test bed. At left he checks his instruments. At right, author Francis has his hand on return-line plumbing from motor to condenser. System produces 350-plus hp., and is designed to operate in outside air temperatures of below zero to 90 degrees and up.

250 degrees it reacts corrosively with Freon. Titanium would be out, too; it reacts at only 100. He admits to the introduction of a filter to remove minor decomposed products.

Minto is chary with information. His patents are pending, and he has a fat contract with a very affluent customer.

Of his boiler he will say only that it is not a monotube. It consists of a large number of short coils feeding into a manifold at the motor-entry end. Because the torque is so prodigious, Minto's computer sharply reduces the flow of gas to the motor if the accelerator is floored at a vehicle speed of less than 15 m.p.h. Above 45, the computer reverses the engine torque if a driver hits the panic button.

"There is absolutely no braking fade," he says.

Minto has a built-in air-conditioning system. Since the Freon reservoir is always liquid under pressure, just spray it through a needle valve into a low-pressure chamber, and collect the cool air. Minto reports full heat from the boiler for winter comfort in 10 seconds.

Quick start. "I can move off in 15 seconds under full power," he says, "after I turn the ignition key."

A spark plug fires up his burner. The motor in his laboratory vehicle, a Volkswagen station wagon, is from a Stanley steamer, vintage 1920. His Freon losses run to about six percent a year. Freon is already available at many filling stations for refilling automobile air conditioners.

So much for now on Wallace Minto and Freon-11.

Bill Lear has some things going for him, too.

In the days of Abner Doble, the real genius of steamers, and the Stanley brothers, who reaped most of the publicity, a throttle valve could not tolerate steam at higher than 600 degrees. So Doble had to put his valve upstream of his superheat region, causing a delay in response of three or four seconds, intolerable to a gasoline motorist.

Today's steels will process steam at superheat without protest. Metals developed for combustion chambers of jet aircraft engines enable Lear engineers to reduce furnace size by two-thirds.

The same combustion phenomenon that permits flights to the moon helps the steam-car power plant. The stainless-steel coils in the Lear steam generator would begin to soften at 1,500 degrees. The furnace produces 4,000. So, to begin with, secondary air is introduced to the boiler under pressure. This cuts the heat to 2,000. The diluted air is ducted to the furnace for combustion.

More heat reduction. A laminar film of insulating gas, like that in the nozzle of space engines, further reduces effective furnace heat around the boiler coils by 600 to 700 degrees. Control of the laminar film can be established by tube configura-

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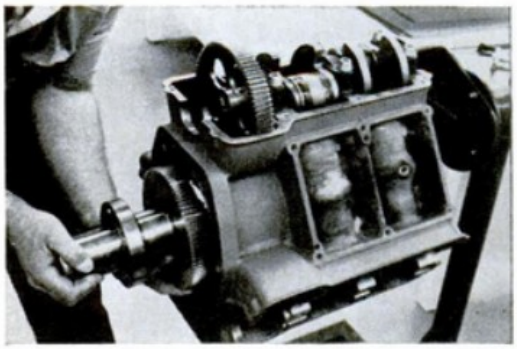
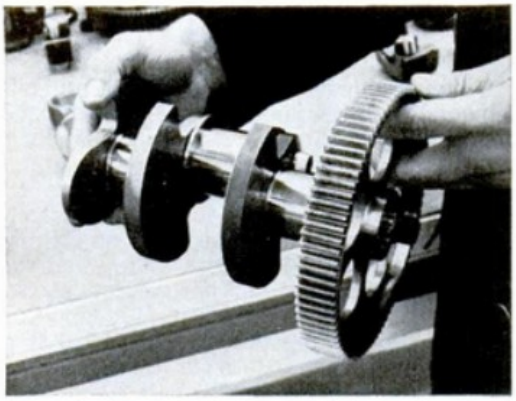
Steam Cars Are Really on the Way

[*Continued from page 49*]

Delta engine's piston and con rod—one of 12—fits into a cylinder with a bore of 2.52 inches, a stroke of 2.25. Six cylinders displace 116 cu. in.



Power takeoff shaft runs through center of triangular engine. Ports in each half cylinder are for both intake and exhaust. Expansion ratio is 15.89:1.



Short, husky crankshaft, one of three, is geared to power-takeoff shaft. Auxiliary turbine, five by nine inches, absorbs 10 percent of power output.

tion and the turbulence of the flue gases. Farther downstream of the furnace, where the flue gases begin to cool, the turbulence is stepped up. This is like sand-blasting the coils—it strips away part of the protective film, affording more heat.

Thermocouples throughout the heat-transfer change system report instantly and continuously—Lear says—to a computer to govern water input and the generation of steam.

Banks of cylinders. Lear uses a delta motor, three banks of two cylinders, each with two pistons. The two pistons double steam-expansion ratio per cylinder, and the design permits a motor tidy in size.

His auxiliary motor is a turbine to drive the pumps for fuel, for circulating water through the condenser, for boiler feedwater, and lube oil. It also drives the blower for combustion air, and such satellite items as the alternator, radiator fan, A/C compressor, and the power-steering and power-brake pumps.

The wastage is prodigious. Vast quantities of heat have been imparted to the water or Freon to vaporize it. Now it must be thrown out to reconvert vapor to liquid. Lear must use a spray condenser to reduce the exhaust steam to water before it is fed to the radiator. Minto's low heats obviate that step. In all, about 65 percent of the heat in the vapor is lost in heat exchange.

"Wastage?" said a Lear engineer. "Forty percent of a gasoline engine's heat goes out the tailpipe, and another 30 is lost through the radiator."

Secret ingredients. A water-soluble additive called Learium—ingredients not disclosed—that will not break down at high temperatures will prevent freeze-ups in cold weather, says Lear.

Lear says that within five seconds after a motorist turns the ignition key in his automobile, his steam generator, cold-soaked to zero, will pour 200-degree air into a space heater for passenger comfort. In 11 seconds, his system will move the vehicle off at a sharp clip, and in 15 will supply full power and torque.

At the moment, Wallace Louis Minto seems to have it made. The U.S. Department of Transportation has given $309,000 to the Dallas Transit System to test

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two buses driven on his Freon-powered motor. The LTV Aerospace Corp., a subsidiary of the prestigious Ling-Temco-Vought industrial complex, will convert the buses—standard General Motors diesel-powered vehicles. They will be running in less than four months.

Two Minto test engines have been run by LTV for more than 1,000 hours each, the equal of 60,000 miles of driving, with no detectable wear.

Another DOT grant has been made to the California State Committee on Transportation for experiments on external-combustion buses in the San Francisco-Oakland area. Lear would like to capture that contract.

The National Air Pollution Control Administration (a branch of the Department of Health, Education and Welfare) will shortly grant a federal contract for the design of a 100-hp. steam power system capable of running a six-passenger car at 75 m.p.h. Five proposals are under evaluation. They were submitted by Andy Granatelli's STP Corp. jointly with Planning Research Corp.; by Ford Motor Co. jointly with Thermo-Electron Corp.; by Continental Motors Corp.; Battelle Memorial Institute; and Ling-Temco-Vought.

If the Department of Transportation is financing buses, not passenger cars, as test beds, it is for an obvious reason—a politically sensitive Washington is loath to spit directly in the eye of the U.S. auto industry, with billions invested in machinery to produce gasoline engines.

Aside from freshened air, the resurrection of the external-combustion engine will be a bonanza to the motorist. Powerplants should cost 50, perhaps 75, percent less than internal combustion engines with their complex power trains and ignition systems. Minto reports 15 m.p.g. in city driving—the engine stops when the car stops—and 25 m.p.g. on the highway at 70 m.p.h.

Though Wallace Minto is about as vocal as a clam, I gathered from other sources that he and LTV are preparing a proposal for a VW-size car. From 50 to 100 of these will be on the road for consumer evaluation by next spring. Limited production for public sale is probable a year later. PS

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